LAB #2. Fall 2009

Spreadsheet Modeling of Population Growth

Introduction:

Modeling population growth involves repetitive iteration of relatively simple equations; procedures that are well suited to spreadsheet analysis.

We will model exponential growth using the equation:

$dN/dt = rN$ [Eq. 1]

and logistic growth using:

$dN/dt = rN(1-(N/K))$ [Eq. 2]

Procedure:

1. Set up an exponential growth model, as you did last week. Input parameters should be the net reproductive rate ($R_{0)}$, generation time (T_{gen}), and starting female-population size(N_0)).
2. Use R_0= 3, T_{gen}=10, N_0=2.

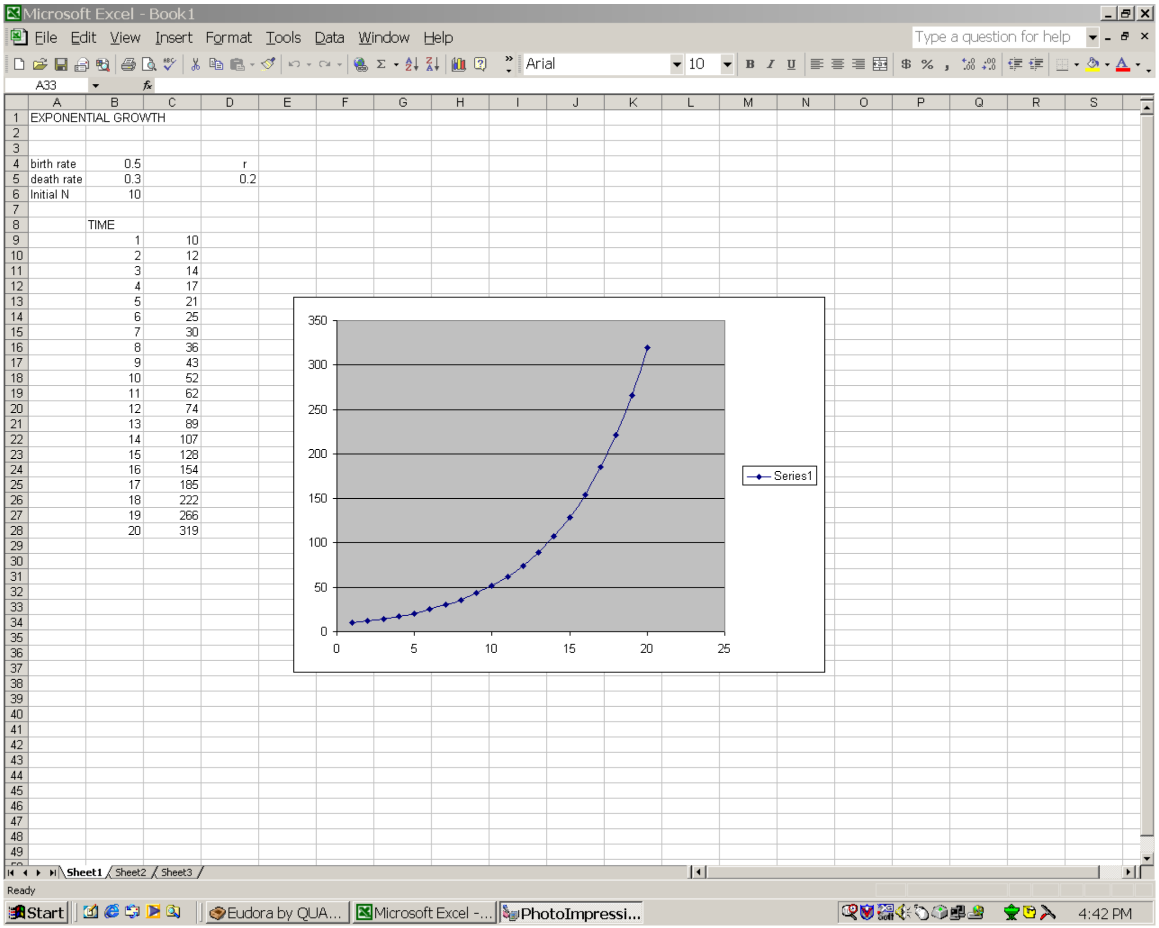
3. Graph the results, and ensure you get the expected result.

Remember, r, the intrinsic rate of increase, is approximated by the natural log of R_0, divided by the generation time. The Excel formula appears thus:

=ABS((LN(B2))/B3)

where LN is the mathematical function to generate natural logs, B2 is the cell address in which R_0 appears, and B3 is the cell address in which the generation time appears. The ABS function gives you the absolute value of the expression, which avoids the problem of negative values resulting from the natural log of values less than 1.

Your spreadsheet should look something like this:



Notice that the whole spreadsheet, including the graph, is "active"; if you change any of the input parameters (R_0, T_{gen}, or N_0), and hit <ENTER>, the whole spreadsheet and the graph will be updated.

4. Experiment by increasing and decreasing R_0 and T_{gen}. How does the population growth curve respond? Modify your spreadsheet to include life-span (recall the rat question in last weeks' lab). Now, Run the model for aardvarks (*Orycteropus afer)*
Life span: 10 years; gestation period: 7 months; time to sexual maturity: 2 years; fecundity: 1 young per year.

. Starting with 1 pregnant female aardvark and assuming exponential growth, **What would be the population size after 10 years? Paste a copy of your 'exponential' aardvark population graph into your lab report.**

LOGISTIC GROWTH.

Using your exponential growth model as the foundation, develop it further to model logistic growth. Obviously, this will require an additional input parameter, the carrying capacity (K). Start with an arbitrary value of K
Check the model to make sure the chart shows the expected “s-shaped” logistic growth curve.

Now rerun the Brown Rat data from last week, using an initial population of 2 females and a carrying capacity of 250 animals. **How long would it take for the population to stabilize at carrying capacity? Paste a copy of your graph into your lab report.**

SYNCHRONIZED GROWTH

The rat irruption documented in the “Rat Attack” video occurred because breeding was synchronized in waves. Download the “Black Rat Irruption Partial Example.xls” file from the course website, and examine it carefully to understand how it works. Extend the time line out to 500 days to see if you can reproduce the “3 waves” of rates documented in the video. **Paste a copy of your graph into your lab report.**

THINGS TO CONSIDER

Go to the internet (or library) and locate some basic natural history data (e.g. number of young, gestation period, life span, etc) for a species of interest to you. Use the data to estimate reasonable values for R_0 and T_{gen}, etc, and choose what seems like a reasonable carrying capacity. **Use your spreadsheet to plot the growth of the species to equilibrium. In what ways is the model unrealistic? What does it not include?**